

Richness and diversity of odonates of the agricultural college and research institute, Vazhavachanur, Tamilnadu, India

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Abstract Investigations on the diversity of Odonata in and around the Agricultural College and Research Institute, Vazhavachanur, Tamil Nadu, India were studied. Eight locations were selected, of which sixteen Odonata species were recorded. In total, eleven dragonfly and five damselfly species were identified from Thiruvannamalai district, Tamil Nadu, India. *Pantala flavescens*, *Diplacodes trivialis*, *Brachythemis contaminata* and *Ischnura aurora* were recorded from all eight locations. *Trithemis pallidinervis* and *Agriocnemis pygmaea* were recorded from seven locations except from the farm pond and the open stretch area. *Rhyothemis variegata* was recorded only at the open stretch area. The results clearly show that, Odonates have specific habitat preferences for their growth and development. Four families Libellulidae, Gomphidae, Aeshnidae and Coenagrionidae were observed and collected during the study. Libellulidae were the most abundant family (56.25%) and comprised of 9 species, followed by Coenagrionidae (31.25%) with 5 species. Low species abundance was recorded within the Gomphidae and Aeshnidae families with 6.25% each. Simpson and Shannon Index showed maximum diversity in the open stretch area (0.8743 and 2.186, respectively) and minimum in location 8 (crop production area) and location 4 (Sathakuppam), respectively. Open stretch area showed maximum Richness Index (Margalef) (2.275) followed by farm pond (2.196) where recorded minimum in sathakuppam (1.276) location. Equitability J index, maximum species evenness (0.788) was recorded Location 6 i.e. farm pond (0.6727) followed by open stretch area 0.686.

Bogactwo i różnorodność ważek z terenu kolegium rolniczego i instytutu badawczego, Vazhavachanur, Tamilnadu, Indie

Słowa kluczowe Vazhavachanur, ważki różnoskrzydłe, ważki równoskrzydłe, Libellulidae i Coenagrionidae

Streszczenie Zbadano różnorodność Odonata w Kolegium Rolniczym i Instytucie Badawczym w Vazhavachanur, Tamil Nadu w Indiach i wokół niego. Wybrano osiem lokalizacji, gdzie

odnotowano 16 gatunków Odonata. Łącznie w okręgu Thiruvannamalai w stanie Tamil Nadu w Indiach zidentyfikowano 11 gatunków ważek różnoskrzydłe i 5 gatunków ważek równoskrzydłych. *Pantala flavescens*, *Diplacodes tryialis*, *Brachythemis contaminata* i *Ischnura aurora* odnotowano we wszystkich ośmiu lokalizacjach. *Trithemis pallidinervis* i *Agriocnemis pygmaea* odnotowano w siedmiu miejscach, z wyjątkiem stawu hodowlanego i otwartego obszaru. *Rhyothemis variegata* odnotowano tylko na otwartym terenie. Wyniki wyraźnie pokazują, że ważki mają określone preferencje siedliskowe dotyczące ich wzrostu i rozwoju. Podczas badań zaobserwowano i zebrano cztery rodziny: Libellulidae, Gomphidae, Aeshnidae i Coenagrionidae. Najliczniejszą rodziną były Libellulidae (56,25%), składające się z 9 gatunków, następnie Coenagrionidae (31,25%) z 5 gatunkami. Niską liczebność gatunków odnotowano w rodzinach Gomphidae i Aeshnidae po 6,25%. Indeks Simpsona i Shannona wykazał maksymalne zróżnicowanie na otwartym obszarze (odpowiednio 0,8743 i 2,186) i minimalne w lokalizacji 8 (obszar upraw) i lokalizacji 4 (Sathakuppam). Otwarty obszar wykazywał maksymalny wskaźnik bogactwa (Margalef) (2,275), następnie był staw hodowlany (2,196), minimalny wskaźnik bogactwa odnotowano w lokalizacji Sathakuppam (1,276). Wskaźnik równości J, maksymalna równość gatunkowa (0,788) odnotowano w lokalizacji 6, tj. Staw hodowlany (0,6727), a następnie na otwartym obszarze (0,686).

Introduction

Odonata are an important predatory order which includes Dragonflies (Anisoptera) and Damselflies (Zygoptera). The odonate larvae are in aquatic habitat and the adults are excellent aerial predators. The insect possess large compound eye which helps to capture the prey comfortably. Of which, dragonflies are performing strong flying activity under the suborder called Anisoptera and damselflies are weak flier under the suborder of Zygoptera (Tofilski, 2004). The insects distributed almost throughout the world (Tillyard, 1917). Selvarasu et al. (2019), reported that it is the second largest aquatic insect order in the animal kingdom. Chovanec and Waringer (2001) reported that Odonates are so sensitive and it will react immediately even small fraction of changes in the habitation. Rowe (2003) reported that, the odonates nymph indirectly helps to control the epidemic diseases of human beings viz., malaria, dengue, filaria, since, the mosquito larvae are aquatic and it will be of good source of food for odonates nymphs. It prefers live fresh water, non-polluted and oxygenated habitats (Manwar et al., 2014). Nesemann et al. (2011) reported that, odonates are playing an important role in climate change mainly due to evolutionary history and its adaptations.

In India, 474 species and 50 subspecies which belongs to 142 genera and 18 families were recorded. Seventeen Odonates species recorded from Howrah district, West Bengal (Dwari, Mondal, 2017) and 36 species from Meghalaya (Acharjee, Karzee, 2016) in India. The Odonates diversity have been studied in all the agro-ecosystems, wherein 31 species were recorded in Amravathi city, Maharashtra (Rathod et al., 2012)

Many studies were carried out on Odonates diversity different parts of Tamil Nadu, viz., 16 species in rice field from Coimbatore district (Gunathilagaraj et al., 1999), 21 species from Coimbatore and Salem district (Arulprakash, Gunathilagaraj, 2010), 29 species from Kanyakumari district (Elanchezhyan et al., 2017) and 8 species were recorded in Mangrove forest (Muthukumaravel et al., 2015). Odonata diversity is lacking in Thiruvannamalai district, Tamil Nadu and hence, the present study have been undertaken for the taxonomic identification, richness and abundance.

Materials and methods

The present study was undertaken in and around Agricultural College and Research Institute, Vazhavachanur, Thiruvannamalai, Tamil Nadu. Annual rainfall of Thiruvannamalai district is 1074.70 mm, the average annual temperature is 28.3°C and it comes under the tropical climate. Thiruvannamalai gets more rainfall during the summer season than winter season. Nearly 45% of the rainfall is received during north east monsoon period (October–December). The sources of water is Sathanur Dam, wells and in some cases bore wells. Most commonly available tree species in our collection premises are Neem, Vaagai, Silk cotton, Tamarind tree, Banyan tree, Peepal tree, Prosopis, etc. and common weed species are *Cyperus*, *Lantana*, *Parthenium*, *Chaff flower*, swollen finger grass, wire weed, Crab grass, *Corchorus* etc.

Wet land ecosystem

It is distinct ecosystem which is inundated by water either permanently or seasonally. In the present study, the paddy crop was used for collection of odonates to study the abundance and species richness. Six different paddy field were selected to observe the abundance of odonates. Each paddy field showed different growth phases and the bunds also were smothered with vigorous weed growth.

Pond (Stagnated water)

To study the Odonata diversity the College farm pond was selected where human interferences is very minimum. The Farm pond gets filled with water during January to March whenever there is flow of water from the canal present near the college boundary. The water will be available for few months and gets dried up during summer.

River canal

It is located adjacent to Thenpennai river for irrigation of farmer field and it is near to campus.

Open land stretch

Barren land were selected to study the diversity.

Geographical information's

Table 1. Geographical information of the different locations

Location details	Latitude (n)	Longitude (e)	Altitude (m)	Crop	Aquatic status	Shade cover
Seed farm 1	12°4'37"	78°58'60"	153.98	Paddy	Seasonal aquatic	Partial
(Paddy field) Near college gate	12°4'18"	78°59'8"	158.98	Paddy	Seasonal aquatic	Partial
Seed farm 2	12°4'28"	78°59'59"	149.98	Paddy	Seasonal aquatic	Partial
Sathakuppam	12°4'18"	78°58'41"	148.98	Paddy	Seasonal aquatic	No
Open stretch area	12°4'33"	78°59'0"	156.98	–	Seasonal aquatic	Partial
Farm pond	12°4'33"	78°59'6"	165.98	–	Temporary	Partial
Seed farm 3	12°4'39"	78°58'83"	164.65	Paddy	Seasonal aquatic	Partial
Crop production area	12°4'22"	78°59'12"	141.98	Paddy	Seasonal aquatic	No

Survey and collection of Odonates

Odonata specimens were collected through direct survey from various locations in and around the Agricultural college campus. The areas surveyed are presented in Plate 1, 2 and 2a. Collections were done by different methods *viz.*, zigzag collection, visual observation were also done. Zigzag method is used to collect odonates by using aerial net along with walk. Transect or zigzag walk conducted to cover the selected areas. This method has been widely used for quantitative sampling encountered while visual survey along transects is used for abundance of insect species. The total number of individuals in each species encountered during six months of sampling period (December 2018 to April 2019) is used for comparing their abundance and diversity.

The collection of insects were done by using a long-handled aerial net. A net opening of at least 30 cm diameter makes the job easier. Some collectors feel that a dark net bag (black or green) is less conspicuous to dragonflies and thus is more effective than a white one. Observing patrolling dragonflies before swinging at them often pays off; positioning yourself in the most advantageous location, especially if it is somewhat concealed, is usually fruitful. When attempting to a dragonfly, move deliberately. Refrain from waving the net around; keep it as inconspicuous as possible. Swing at fast-flying agile species from behind as they fly by; many will easily dodge a net swung head-on. Collected insects were anaesthetized and preserved properly for further studies.

The collected odonates were photographed for the species identification. Odonate richness, abundance and diversity (Ludwig, Reynolds, 1998) was calculated by using the software 'Biodiversity Calculator': http://www.alyoung.com/labs/biodiversity_calculator.html.

Results

A total of 16 odonates species representing 4 families *viz.*, Libellulidae (9), Gomphidae (1), Aeshnidae (1) and Coenagrionidae (5) were observed and taxonomic studies were studied. The detailed taxonomic identification from genera, species, family level have been identified.

Diversity of Odonata

Out of 11 dragonfly species, *Pantala flavescens* were observed from paddy field and Open stretch area and recorded more population (303 ind.) followed by *Diplacodes trivialis* (195 ind.) observed from farm pond and least populations were recorded from *Anax* sp. (2 ind.) were observed from open stretch area (Table 2).

Table 2. Diversity of odonata in & around ac&ri, Vazhavachanur from December to April

No.	Common name	Scientific Name	Family	Habitat	Abundance (Nos.)
Dragonfly					
1.	Wandering glider	<i>Pantala flavescens</i> (Fabricius, 1798)	Libellulidae	Paddy field & Open stretch area	303
2.	Chalky percher	<i>Diplacodes trivialis</i> (Rambur, 1842)	Libellulidae	Farm pond	195
3.	Ditch jewel	<i>Brachythemis contaminata</i> (Fabricius, 1793)	Libellulidae	Paddy field & Open stretch area	98
4.	Coral- tailed cloud wing	<i>Tholymis tillarga</i> (Fabricius, 1793)	Libellulidae	Farm pond	43

Continuation of Table 2

5.	Long – legged marsh glider	<i>Trithemis pallidinervis</i> (Kirby, 1889)	Libellulidae	Paddy field	142				
6.	Scarlet skimmer	<i>Crocothemis servilia</i> (Drury, 1770)	Libellulidae	Paddy field & Open stretch area	67				
7.	Slender skimmer	<i>Orthetrum sabina</i> (Drury, 1770)	Libellulidae	Open stretch area	39				
8.	Variegated flutterer	<i>Rhyothemis variegata</i> (Linnaeus, 1763)	Libellulidae	Openstretch area	5				
9.	Common club tail	<i>Ictinogomphus rapax</i> (Rambur, 1842)	Gomphidae	Farm pond	9				
10.	–	<i>Anox</i> sp.	Aeshnidae	Open stretch area	2				
11.	Asian pintail	<i>Acisoma panorpoides</i> (Rambur, 1842)	Libellulidae	Open stretch area	8				
Damselfly									
1.	Yellow wax tail	<i>Ceriagrion coromandelium</i> (Fabricius, 1798)	Coenagrionidae	Paddy field & Farm pond	41				
2.	Blue river damsel	<i>Pseudagrion microcephalum</i> (Rambur, 1842)	Coenagrionidae	Farm pond	51				
3.	Golden darlet	<i>Ischnura aurora</i> (Brauer, 1865)	Coenagrionidae	Paddy field	502				
4.	Wandering midget	<i>Agriocnemis pygmaea</i> (Rambur, 1842)	Coenagrionidae	Paddy field	283				
5.	Marsh blue tail	<i>Ischnura senegalensis</i> (Rambur, 1842)	Coenagrionidae	Farm pond	32				
Total					1,820				
Details		Loc 1	Loc 2	Loc 3	Loc 4	Loc 5	Loc 6	Loc 7	Loc 8
Dragonfly									
<i>Pantala flavescens</i>		✓	✓	✓	✓	✓	✓	✓	✓
Diplocodes trivialis		✓	✓	✓	✓	✓	✓	✓	✓
Brachythemis contaminata		✓	✓	✓	✓	✓	✓	✓	✓
Tholymis tillarga		–	–	–	–	–	✓	–	–
Trithemis pallidinervis		✓	✓	✓	✓	✓	–	✓	✓
Crocothemis servilia		✓	✓	✓	–	✓	✓	✓	–
Orthetrum sabina		✓	✓	✓	✓	✓	✓	✓	–
Rhyothemis variegata		–	–	–	–	✓	–	–	–
Ictinogomphus rapax		–	–	–	–	✓	✓	–	–
<i>Anax</i> sp.		–	–	–	–	✓	–	–	–
Acisoma panorpoides		–	–	–	–	✓	✓	–	–
Damselfly									
<i>Ceriagrion coromandelium</i>		–	–	✓	–	✓	✓	–	–
Pseudoagrion microcephalum		–	–	–	–	✓	✓	–	–
Ishnura aurora		✓	✓	✓	✓	✓	✓	✓	✓
Agriocnemis pygmaea		✓	✓	✓	✓	✓	✓	✓	✓
Ishnura senegalensis		–	–	–	–	✓	✓	–	–

Out of 5 damselfly species, *Ischnura aurora* (502 ind.) dominated in and around the AC&RI, Vazhavachanur campus which was recorded from paddy field followed by *Agriocnemis pygmaea* (283 ind.) also recorded from Paddy field and *Ischnura senegalensis* (32 ind.) recorded very less population from farm pond in our campus.

Diversity of Odonata in different locations

The dragonflies, *Pantala flavescens*, *Diplacodes trivialis* and *Brachythemis contaminata* and damselfly species, *Ischnura aurora* were recorded from all eight location (Table 3).

Table 3. Diversity of Odonata in different locations

Loc 1: Seed farm 1	Loc 5: Open stretch land
Loc 2: Paddy field (Near college gate)	Loc 6: Farm pond
Loc 3: Seed farm 2	Loc 7: Seed farm3
Loc 4: Sathakuppam	Loc 8: Crop production area

Trithemis pallidinervis and *Agriocnemis pygmaea* recorded seven locations except farm pond and open stretch area. Whereas, *Rhyothemis variegata* recorded only one location i.e., open stretch area. The results clearly shows that, Odonates have specific habitat for its growth and development.

Odonata diversity in different family level

Representatives of four families viz., Libellulidae, Gomphidae, Aeshnidae and Coenagrionidae were observed and collected during the study. Out of four families, Libellulidae occupies maximum abundance (56.25%) which comprises of 9 dragonfly species, followed by Coenagrionidae (31.25%) occupies 5 damselfly species and minimum of Gomphidae and Aeshnidae recorded 6.25% and 6.25%, respectively (Figure 1).

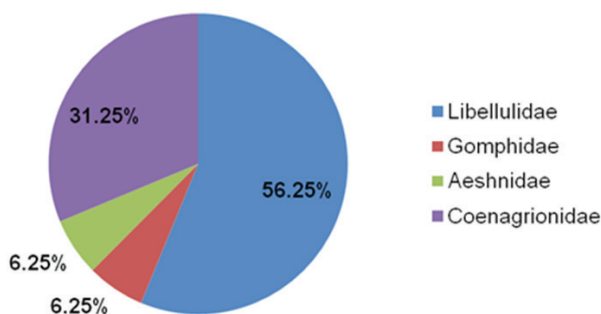


Figure 1. Abundance of Odonata in different families

Abundance and Diversity of Odonata

Simpson and Shannon Index showed maximum diversity in the open stretch area (0.8743 and 2.186, respectively) and minimum in location 8 (crop production area) and location 4 (Sathakuppam), respectively (Table 4). Open stretch area showed maximum Richness Index

(Margalef) (2.275) followed by farm pond (2.196) where recorded minimum in Sathakuppam (1.276) location. Equitability J index, maximum species evenness (0.788) was recorded Location 6 i.e. farm pond (0.6727) followed by open stretch area 0.686.

Table 4. Abundance and diversity of Odonata

Location	Simpson dominance index	Shannon index	Margalef richness index	Evenness
Location 1	0.6777	1.391	1.427	0.502
Location 2	0.7996	1.691	1.665	0.609
Location 3	0.8176	1.766	1.831	0.637
Location 4	0.6015	1.242	1.276	0.448
Location 5	0.8103	1.904	2.275	0.686
Location 6	0.8743	2.186	2.196	0.788
Location 7	0.8165	1.752	1.659	0.632
Location 8	0.6727	1.281	1.385	0.462

Loc 1: Seed farm 1.

Loc 2: Paddy field (Near college gate).

Loc 3: Seed farm 2.

Loc 4: Sathakuppam.

Loc 5: Open stretch land.

Loc 6: Farm pond.

Loc 7: Seed farm 3.

Loc 8: Crop production area.

Discussion

Odonates are extremely susceptible to the insecticides and the number of doses will be increased in the rice field, the abundance also reduced (Smith, Straton, 1986; Tang, Siegfried, 1995).

The odonata family Libellulidae was the widespread species and this was in accordance with the result of Shelton and Edwards (1983). In our study also, the Libellulidae family accounts 56.25% besides four families. It clearly shows that, this family is one of the most prevalent one all over the globe. Biotic and abiotic factors straightly affect the odonate insect inhabitants (Kittelsohn 2004; Goldsmith 2007; Bispo, Oliveira 2007).

Damselfly population was recorded minimum when compare to dragonfly in this study. This is in accordance with the results of Weir (1974) who stated that less abundance is mainly due to their limited dispersal ability and Clark and Samways (1996) reported that partial/ absence of shade cover. Arulprakash and Gunathilagaraj (2010) also reported that shade over the habitat which facilitates rich abundance of damselflies. Maximum Odonates were observed and recorded from the farm pond area. This was in accordance with the studies of Baruah and Saikia (2015) i.e., water bodies will attract the insects.

Krishnasamy et al. (1984), Asaithambi and Manikavasagam (2002) and Bhattacharya et al. (2006) reported that *Diplacodes trivialis*, *Pantala flavescens*, *Orthetrum sabina* (Anisoptera), *Ischnura aurora* and *Agriocnemis pygmaea* (Zygoptera) were the dominant species and observed from transplanting to harvesting stage. This was also in accordance with the present study.

Open Stretch area recorded maximum richness (2.275) followed by farm pond (2.196) in our study, where as Baruah and Saikia (2015) also reported that species richness or Margalef's richness (DMg) index was found to be maximum in open tracts.

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